

Grassland Bypass Project

Biota Monitoring

1992 to 2009

Thomas Maurer and

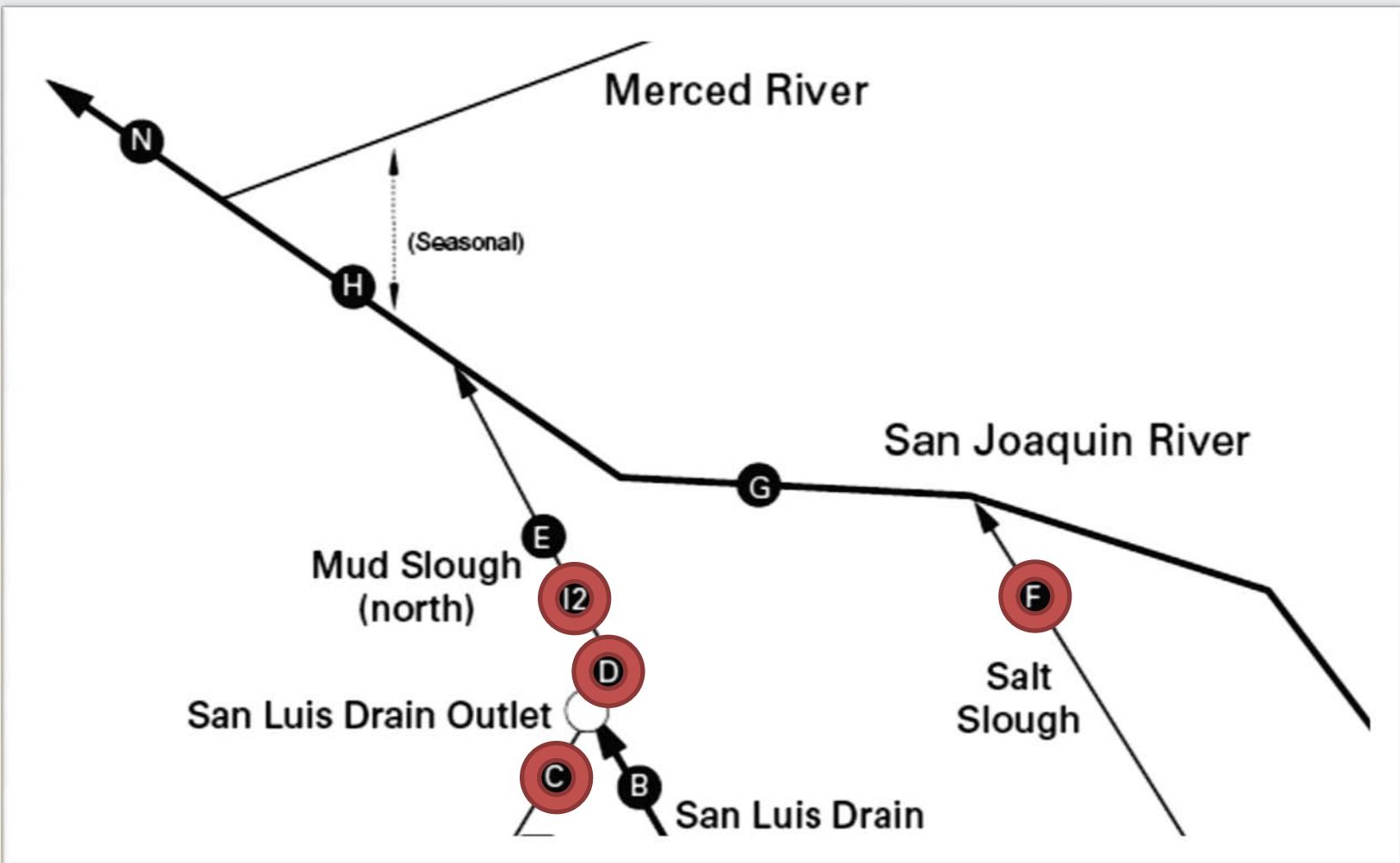
William Beckon

U.S. Fish and Wildlife Service

Introduction

- U.S. Fish and Wildlife Service sampling primary slough sites since 1992;
- Plants, invertebrates, amphibians, fish, bird eggs;
- Quarterly – March, June, August, November
- Grassland Revisited 2004-2005
- Selenium water to biota lag time analysis

Locations



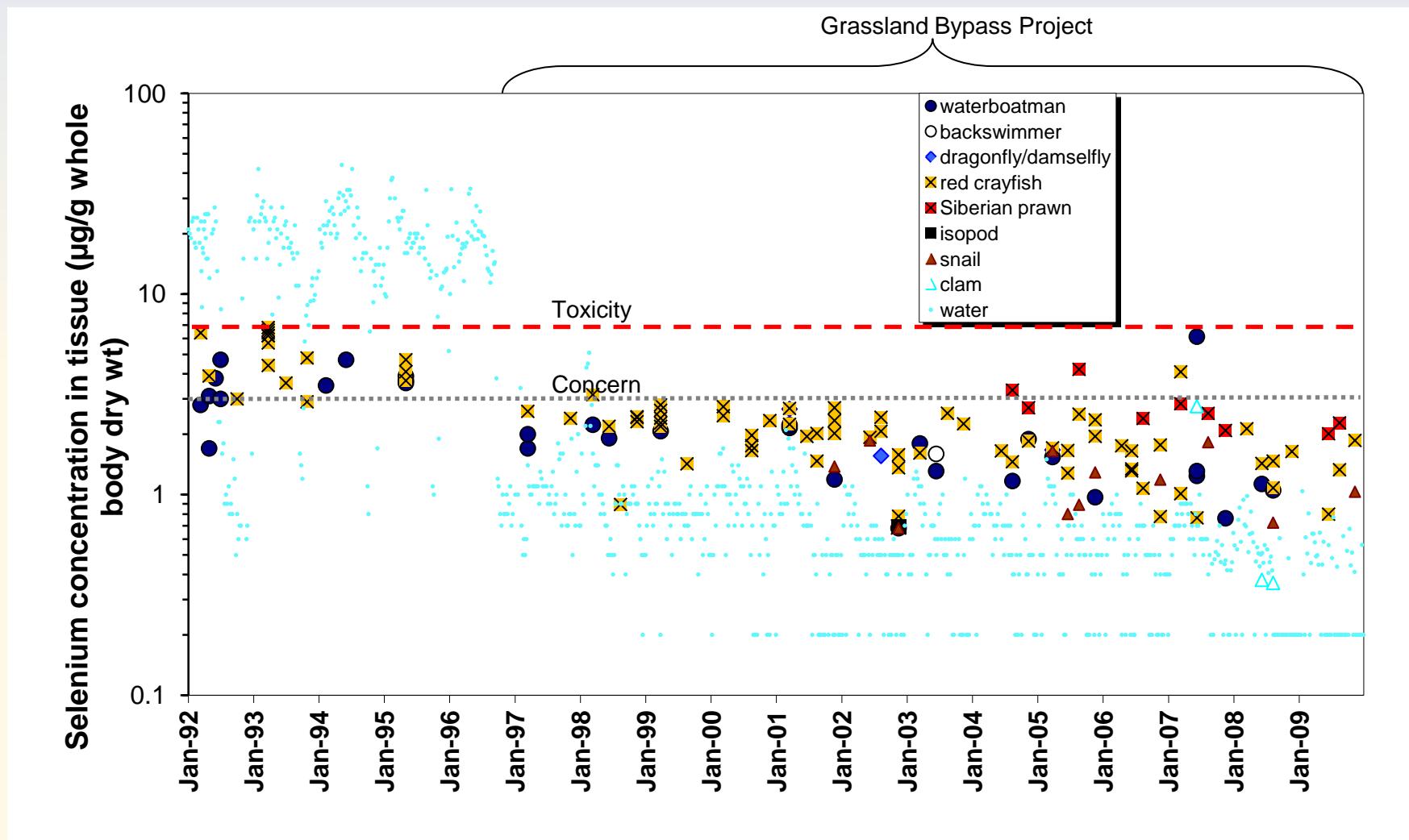
Methods

- Collection:
 - seines, dip nets, electroshock, hand
- Analyses:
 - Se at CDFG Water Pollution Laboratory
 - pre-1996 samples USFWS contract lab and CDFG

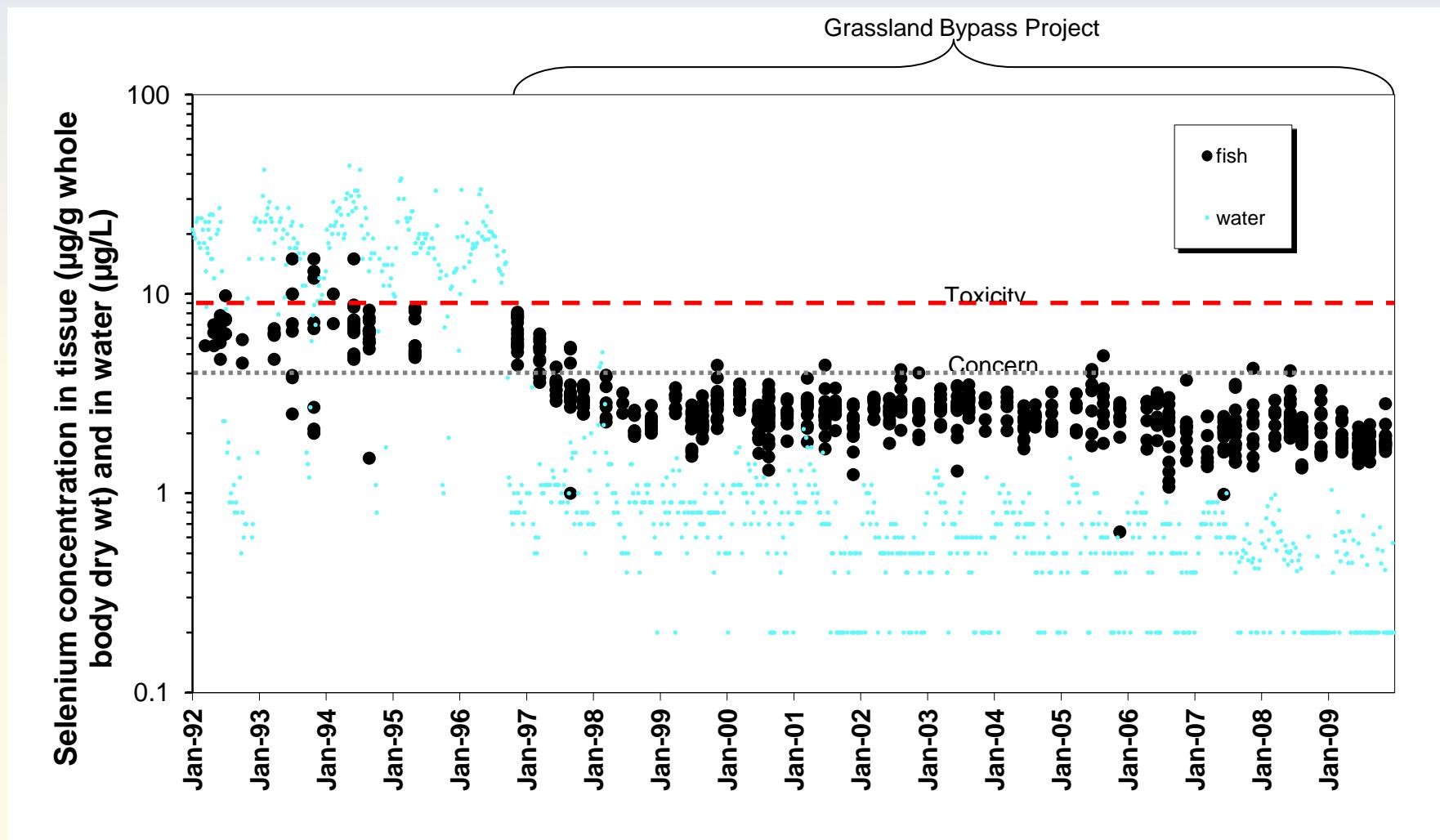
Selenium Levels of Concern

Medium	Effects on	Units	No Effect	Concern	Toxicity
Water (total recoverable Se)	fish and bird reproduction	µg/L	< 2	2 – 5	> 5
Sediment	fish and bird reproduction	µg/g (dry weight)	< 2	2 – 4	> 4
Invertebrates (as diet)	bird reproduction	µg/g (dry weight)	< 3	3 – 7	> 7
Warmwater Fish (whole body)	fish growth/condition/ survival	µg/g (dry weight)	< 4	4 – 9	> 9
Avian egg	egg hatchability (via foodchain)	µg/g (dry weight)	< 6	6 – 10	> 10
Vegetation (as diet)	bird reproduction	µg/g (dry weight)	< 3	3 – 7	> 7

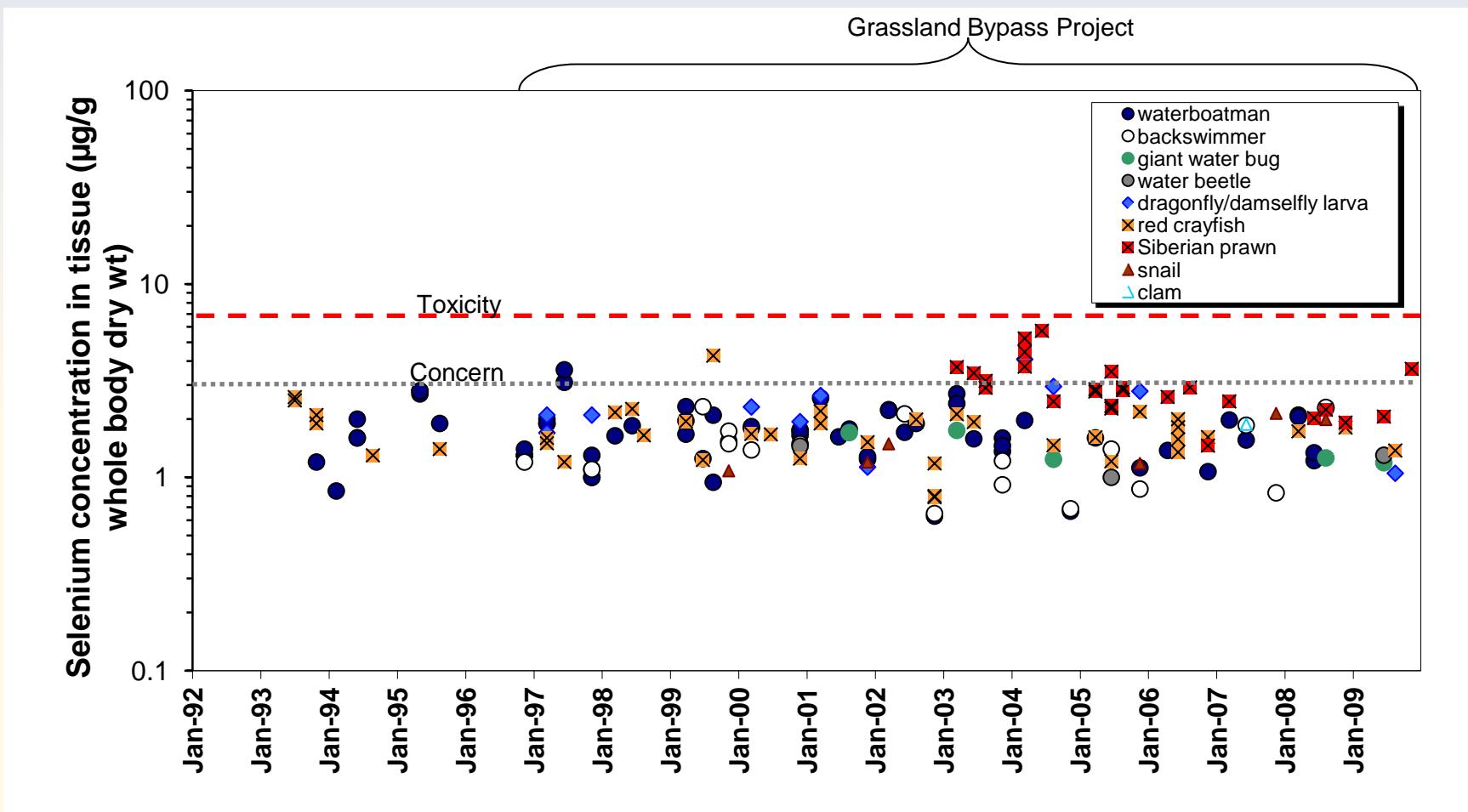
Site F - Invertebrates



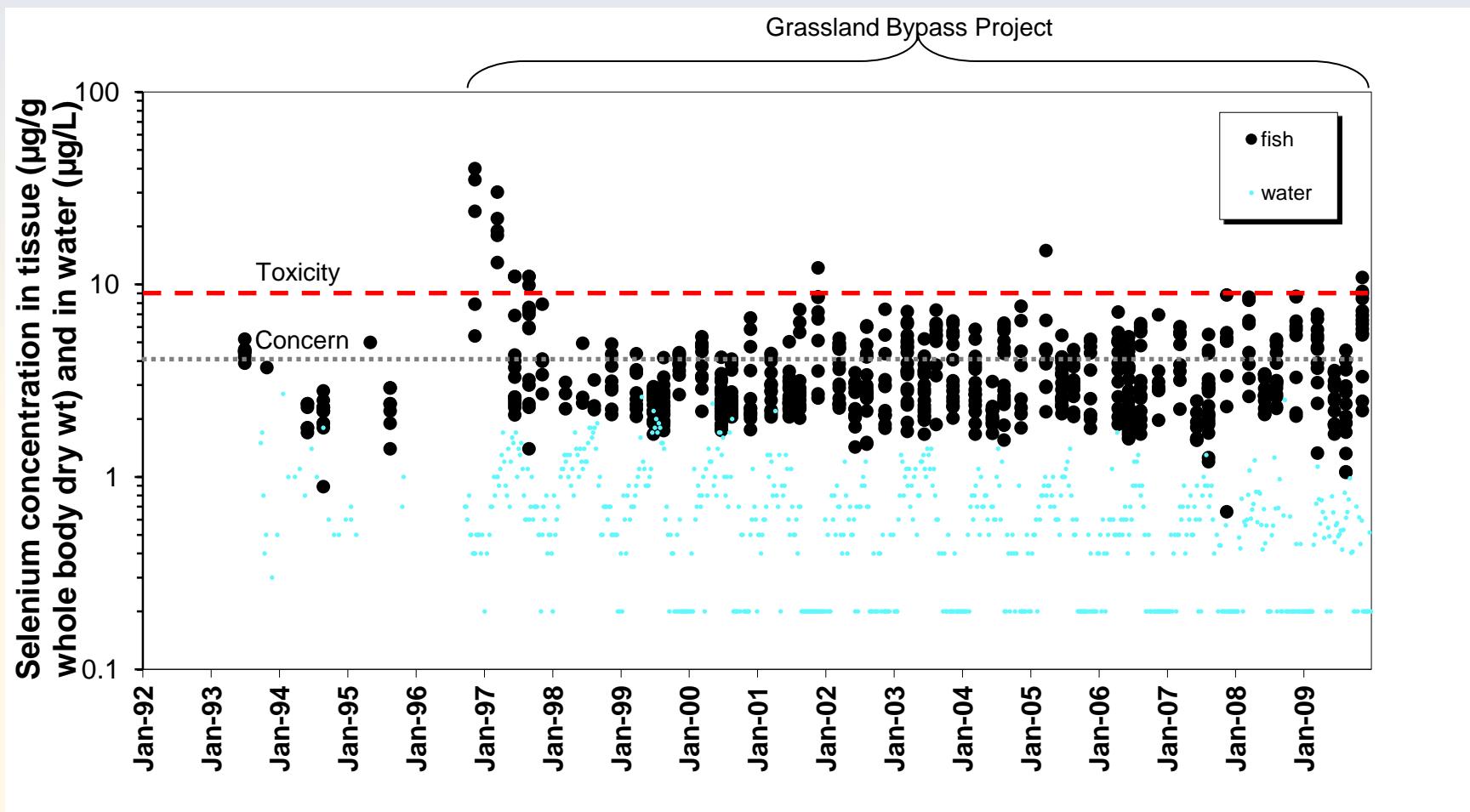
Site F - Fish



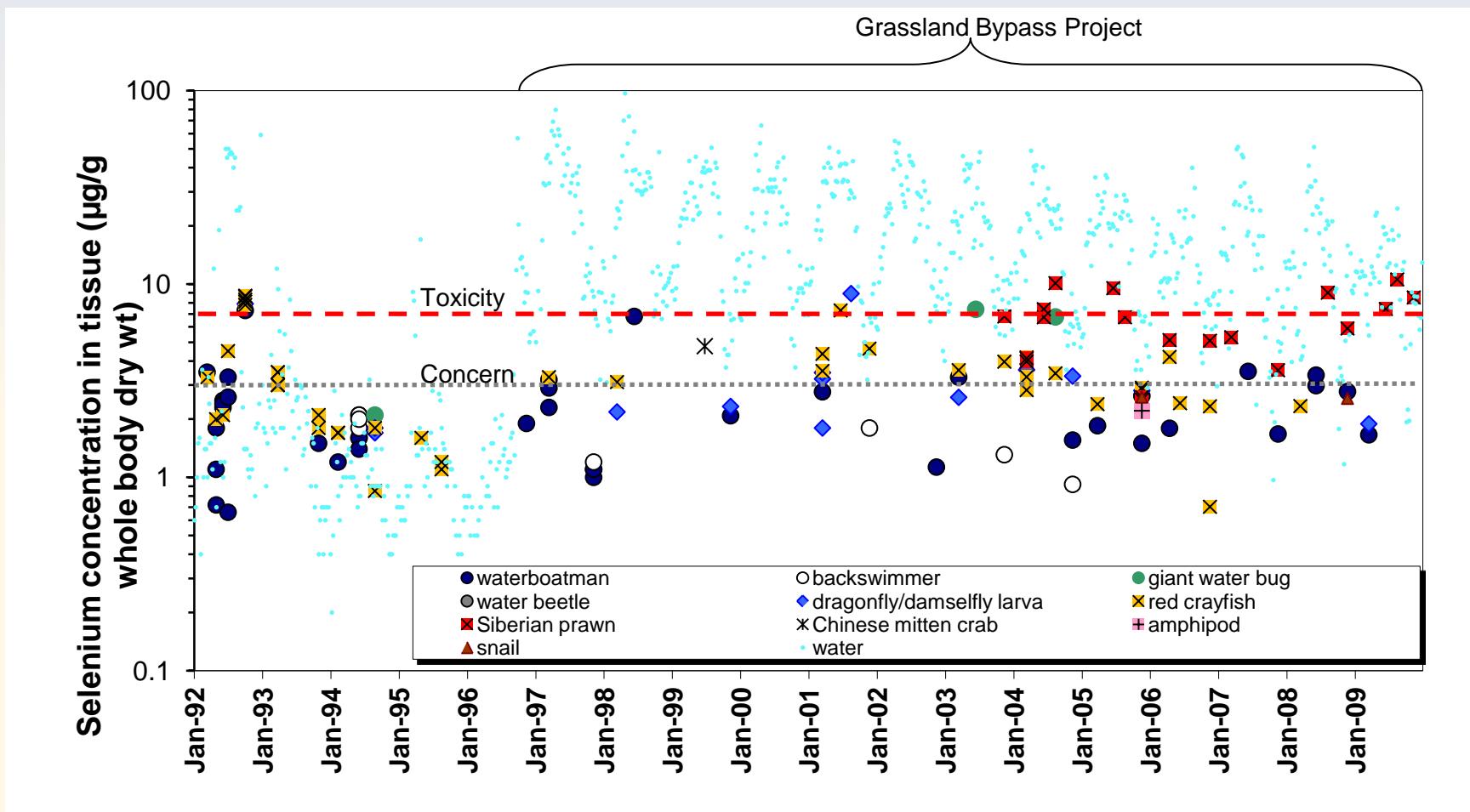
Site C - Invertebrates



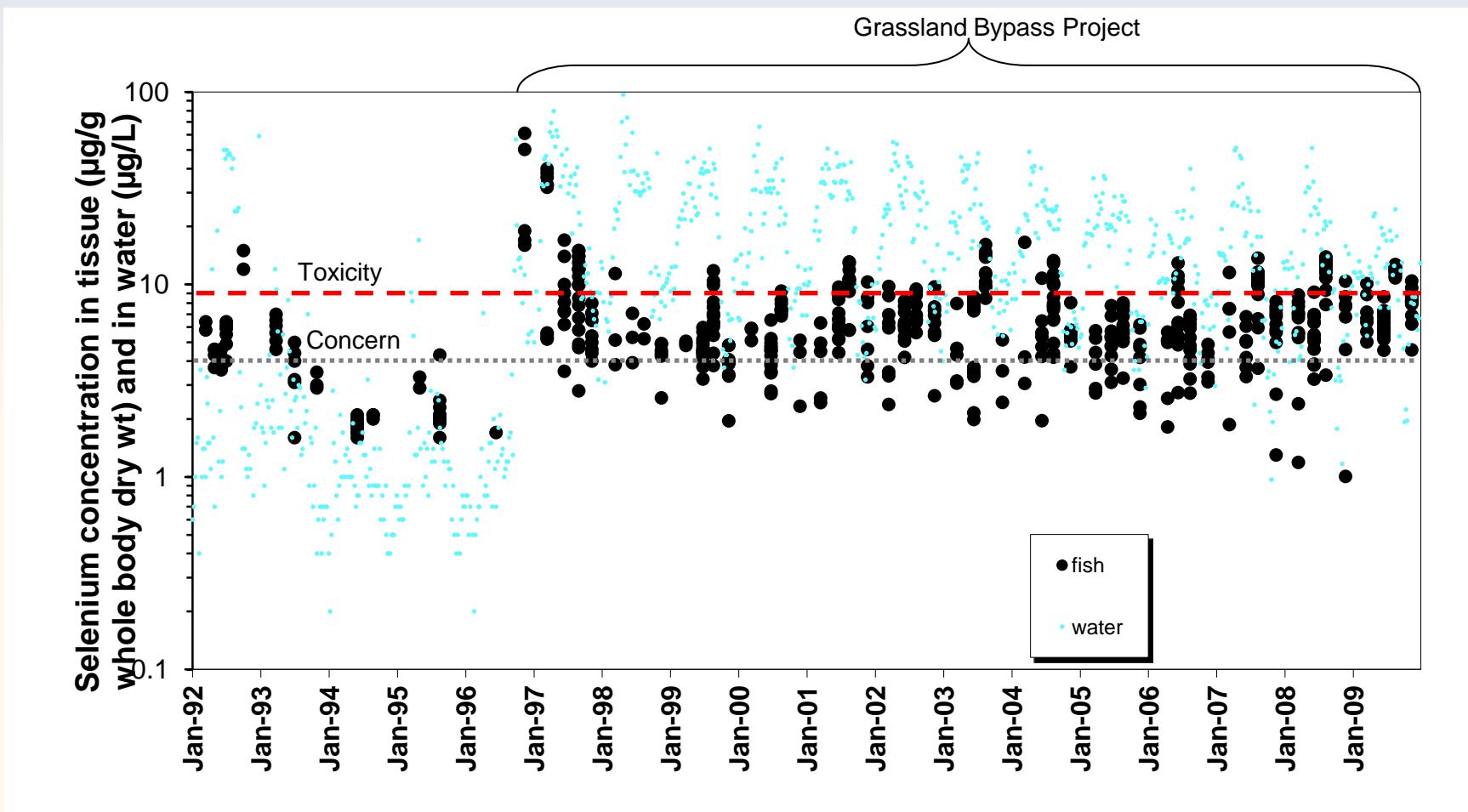
Site C - Fish



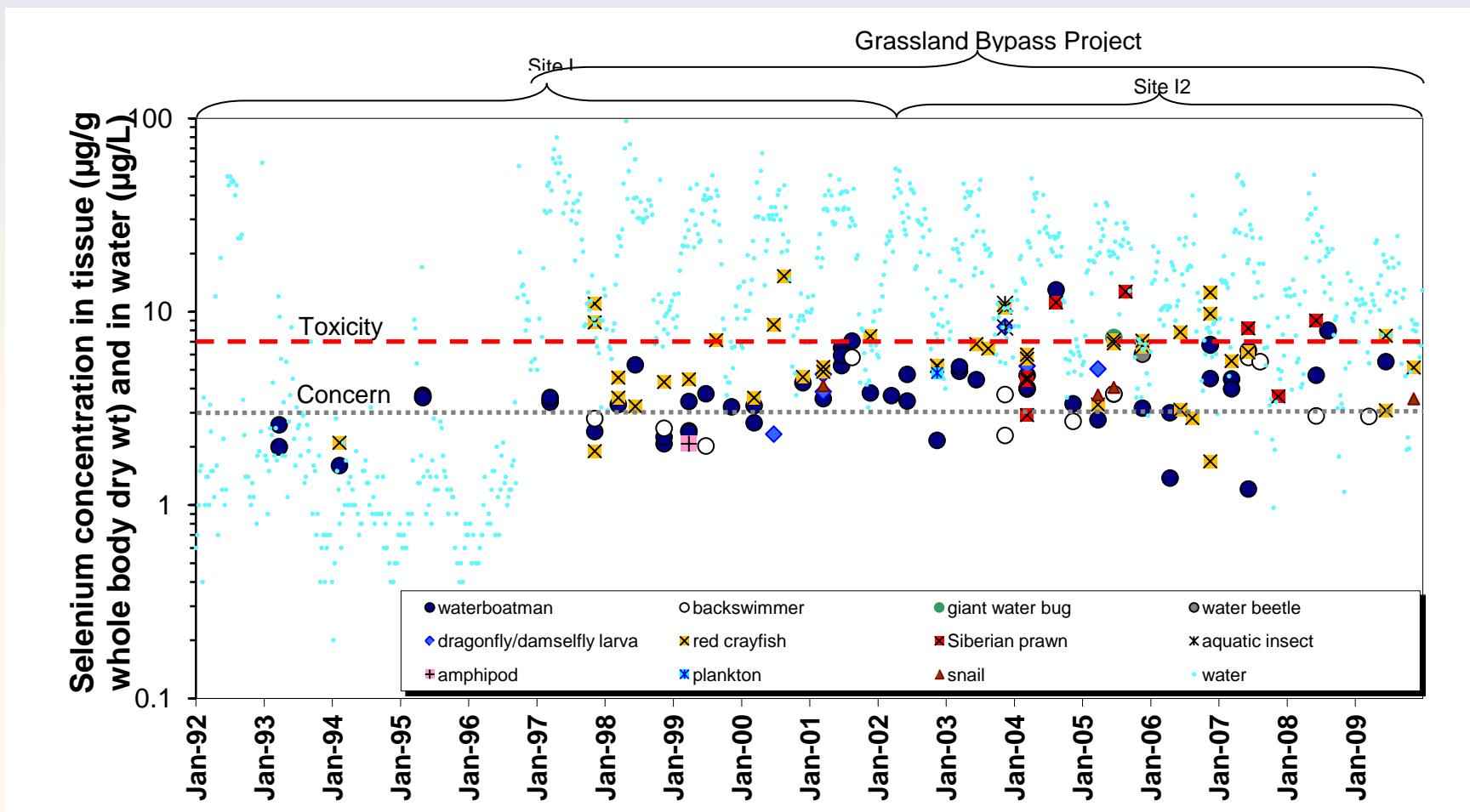
Site D - Invertebrates



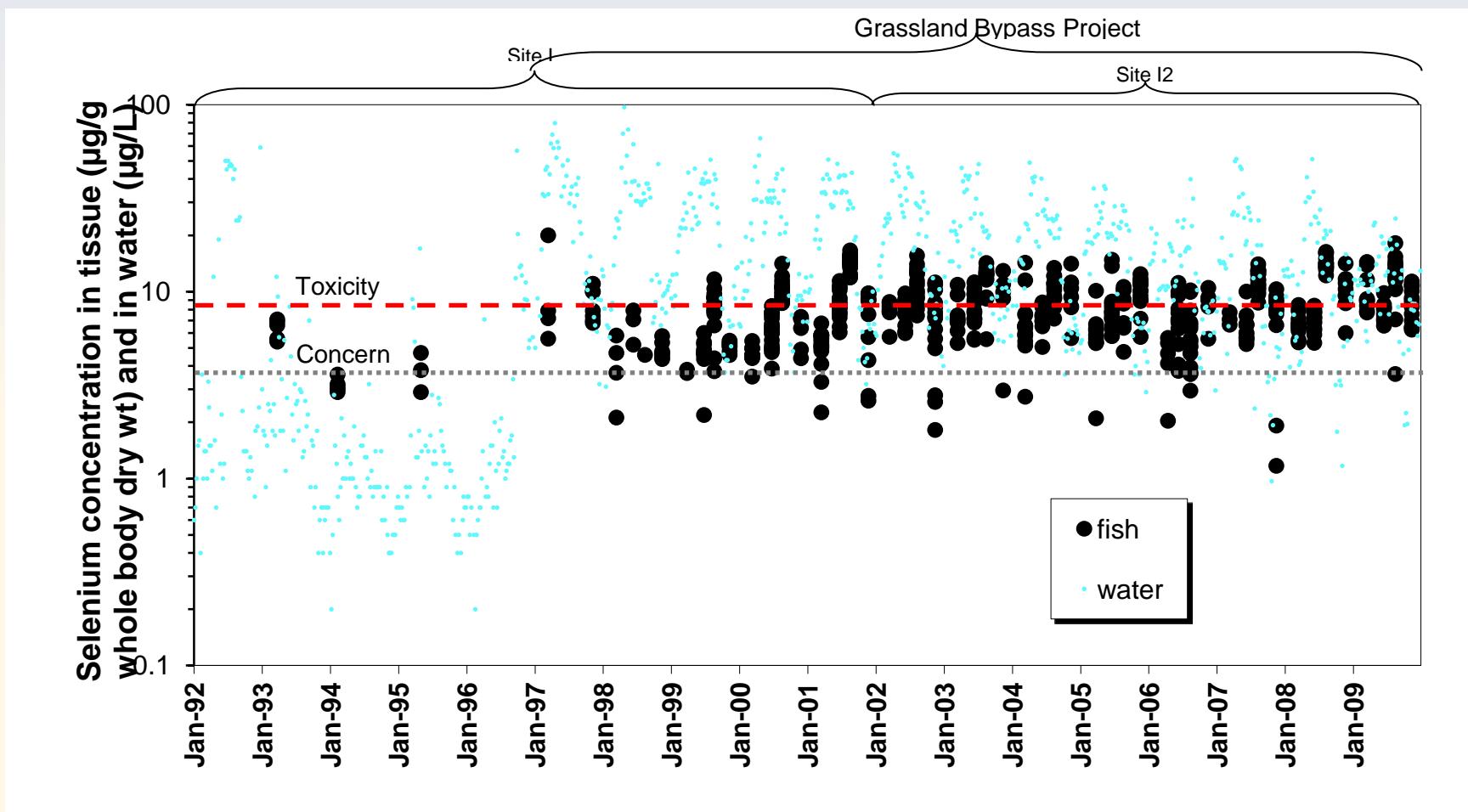
Site D - Fish



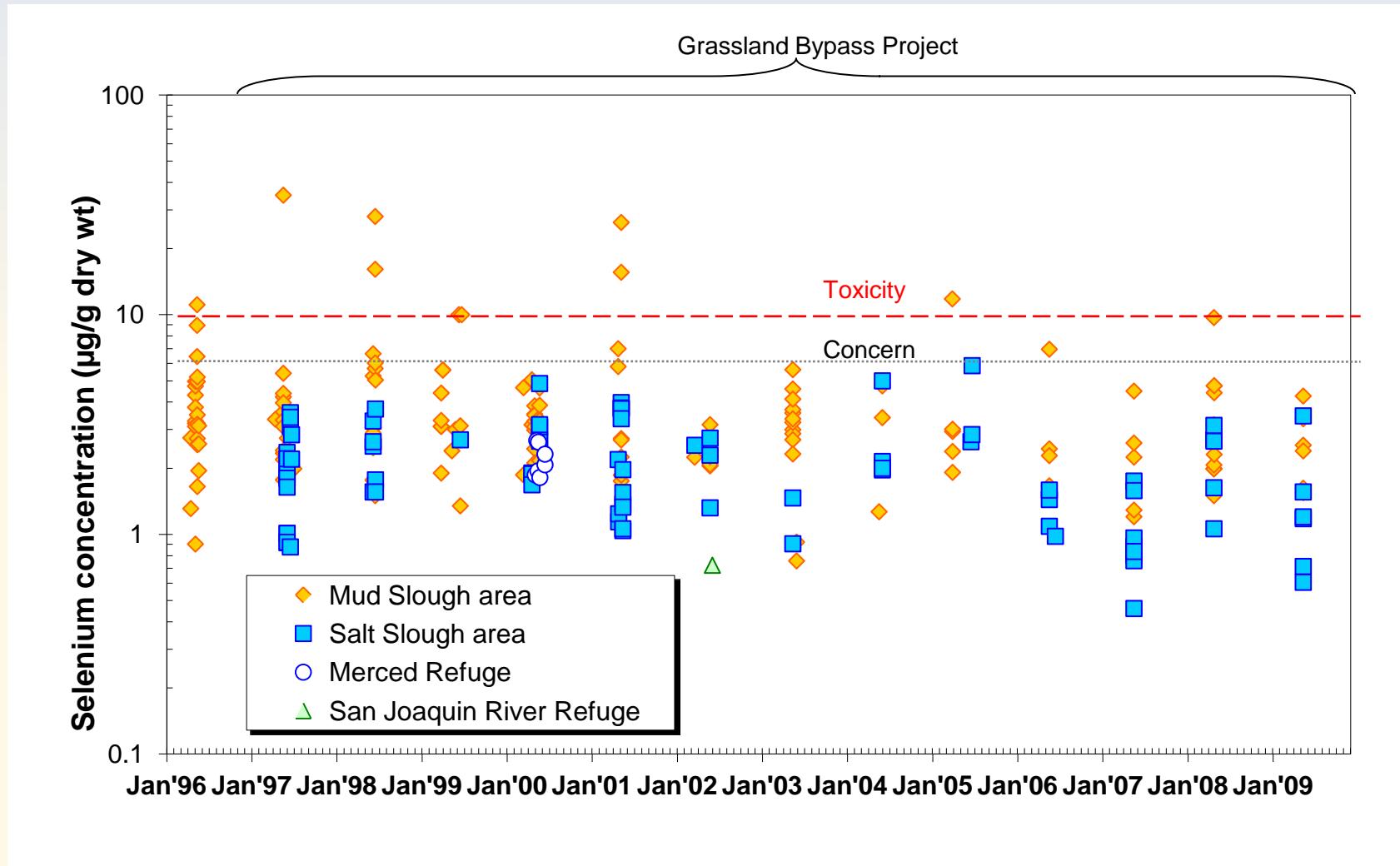
Site I - Invertebrates



Site I - Fish



Bird Eggs – All Sites



Lemly Aquatic Hazard Assessment

- Sums the effects of selenium on various ecological components (water, sediment, invertebrates, fish eggs, bird eggs).
- Uses maximum values rather than mean thus it is sensitive to spikes and outliers.
- Dependent on sampling frequency and timing.

Hazard Scale		TOTAL HAZARD SCORE	
5.0	high	16 - 25	High
4.0	moderate	12 - 15	Moderate
3.0	low	9 - 11	Low
2.0	minimal	6 - 8	Minimal
1.0	none	0 - 5	None

Lemly Aquatic Hazard Assessment

Salt Slough – Pre-project

	Units	Maximum Selenium Concentration	Lemly Aquatic Hazard	Hazard Scale	
		BEFORE PROJECT 1995 - Sept. 1996			
Water	µg/L	38	high	5	
Sediment	µg/g	0.8	none	1	
Invertebrates	µg/g	4.7	moderate	4	
Fish eggs	µg/g	28.1	high	5	
Bird eggs	µg/g	5.2	low	3	
TOTAL HAZARD SCORE			High	18	

Hazard Scale	
5.0	high
4.0	moderate
3.0	low
2.0	minimal
1.0	none

TOTAL HAZARD SCORE	
16 - 25	High
12 - 15	Moderate
9 - 11	Low
6 - 8	Minimal
0 - 5	None

Lemly Aquatic Hazard Assessment

Salt Slough – 2008-2009

		Grassland Bypass Project Phase II					
		Calendar Year 2008			Calendar Year 2009		
Water	µg/L	1.0	minimal	2	1.0	minimal	2
Sediment	µg/g	0.7	none	1	0.6	none	1
Invertebrates	µg/g	2.1	minimal	2	2.3	minimal	2
Fish eggs	µg/g	13.4	moderate	4	9.2	low	3
Bird eggs	µg/g	3.1	minimal	1	3.5	minimal	1
TOTAL HAZARD SCORE			Low	10		Low	9

Hazard Scale		TOTAL HAZARD SCORE	
5.0	high	16 - 25	High
4.0	moderate	12 - 15	Moderate
3.0	low	9 - 11	Low
2.0	minimal	6 - 8	Minimal
1.0	none	0 - 5	None

Lemly Aquatic Hazard Assessment

Mud Slough (D) – Pre-project

	Units	Maximum Selenium Concentration	Lemly Aquatic Hazard	Hazard Scale	
		BEFORE PROJECT 1995 - Sept. 1996			
Water	µg/L	19	high	5	
Sediment	µg/g	0.4	none	1	
Invertebrates	µg/g	1.6	none	1	
Fish eggs	µg/g	14.2	moderate	4	
Bird eggs	µg/g	3.1	minimal	2	
TOTAL HAZARD SCORE			Moderate	13	

Hazard Scale	
5.0	high
4.0	moderate
3.0	low
2.0	minimal
1.0	none

TOTAL HAZARD SCORE	
16 - 25	High
12 - 15	Moderate
9 - 11	Low
6 - 8	Minimal
0 - 5	None

Lemly Aquatic Hazard Assessment

Mud Slough (D) – 2008-2009

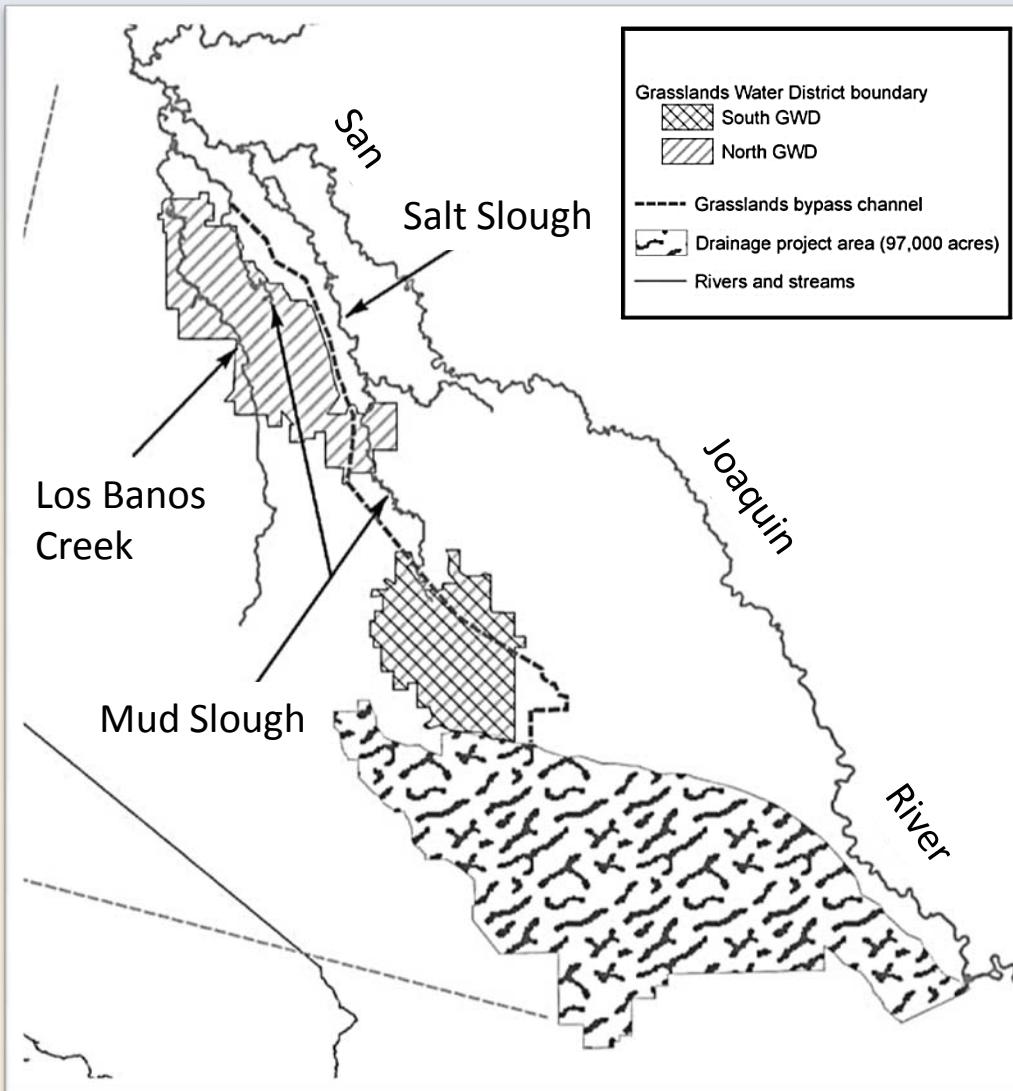
		GRASSLAND BYPASS PROJECT Phase II					
		Calendar Year 2008			Calendar Year 2009		
Water	µg/L	51.0	high	5	24.6	high	5
Sediment	µg/g	1.5	low	3	1.0	low	3
Invertebrates	µg/g	9	high	5	10.6	high	5
Fish eggs	µg/g	53.8	high	5	60,1	high	5
Bird eggs	µg/g	9.7	low	3	4.3	minimal	2
TOTAL HAZARD SCORE			High	21		High	20

Hazard Scale		TOTAL HAZARD SCORE	
5.0	high	16 - 25	High
4.0	moderate	12 - 15	Moderate
3.0	low	9 - 11	Low
2.0	minimal	6 - 8	Minimal
1.0	none	0 - 5	None

Grassland Revisited

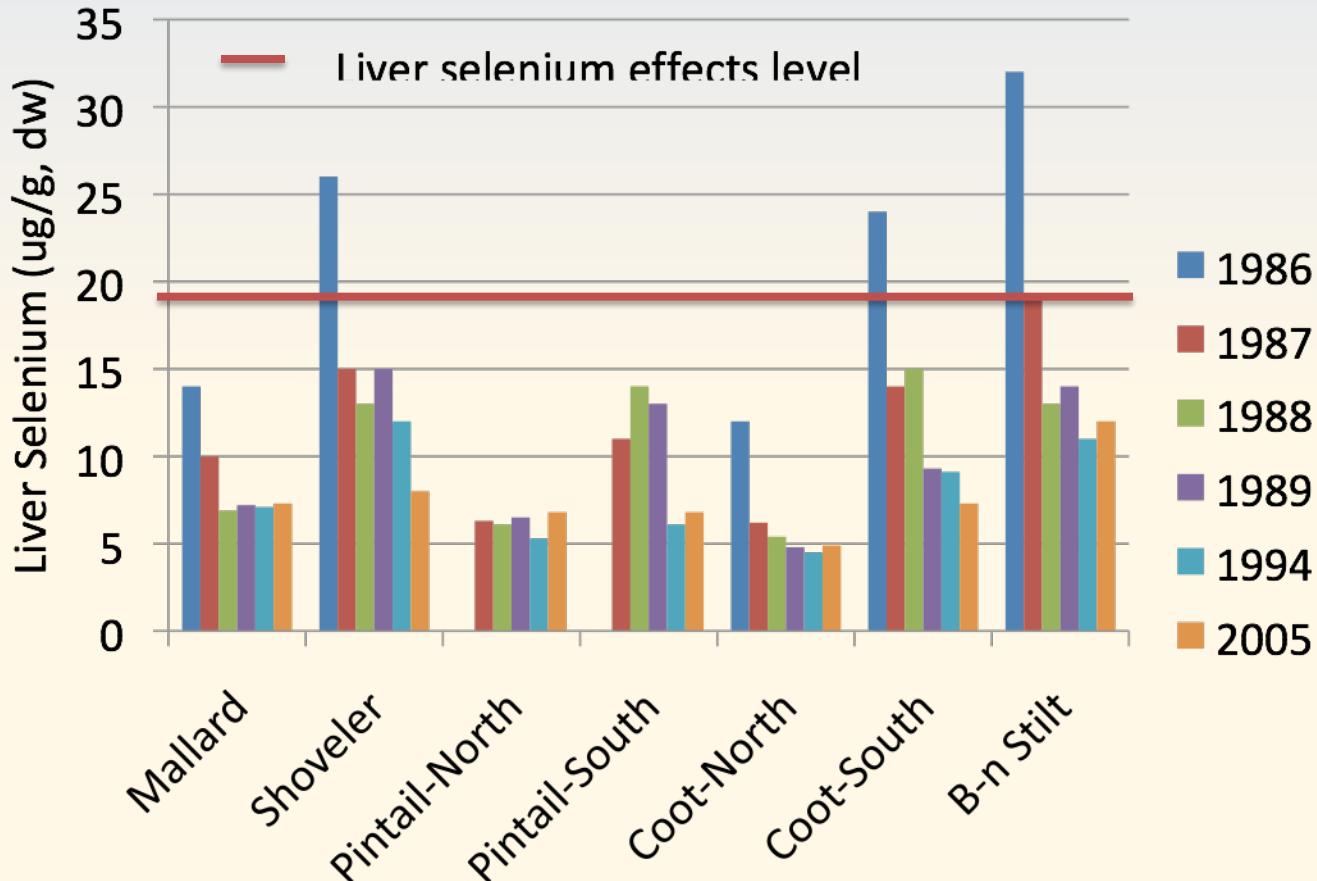
- 2004-2005 collections across North and South Grassland Water District.
- Waterbird livers and eggs.
- Compared to liver and egg threshold effect levels and previous surveys in late 1980s and mid 1990s.

Grassland Revisited



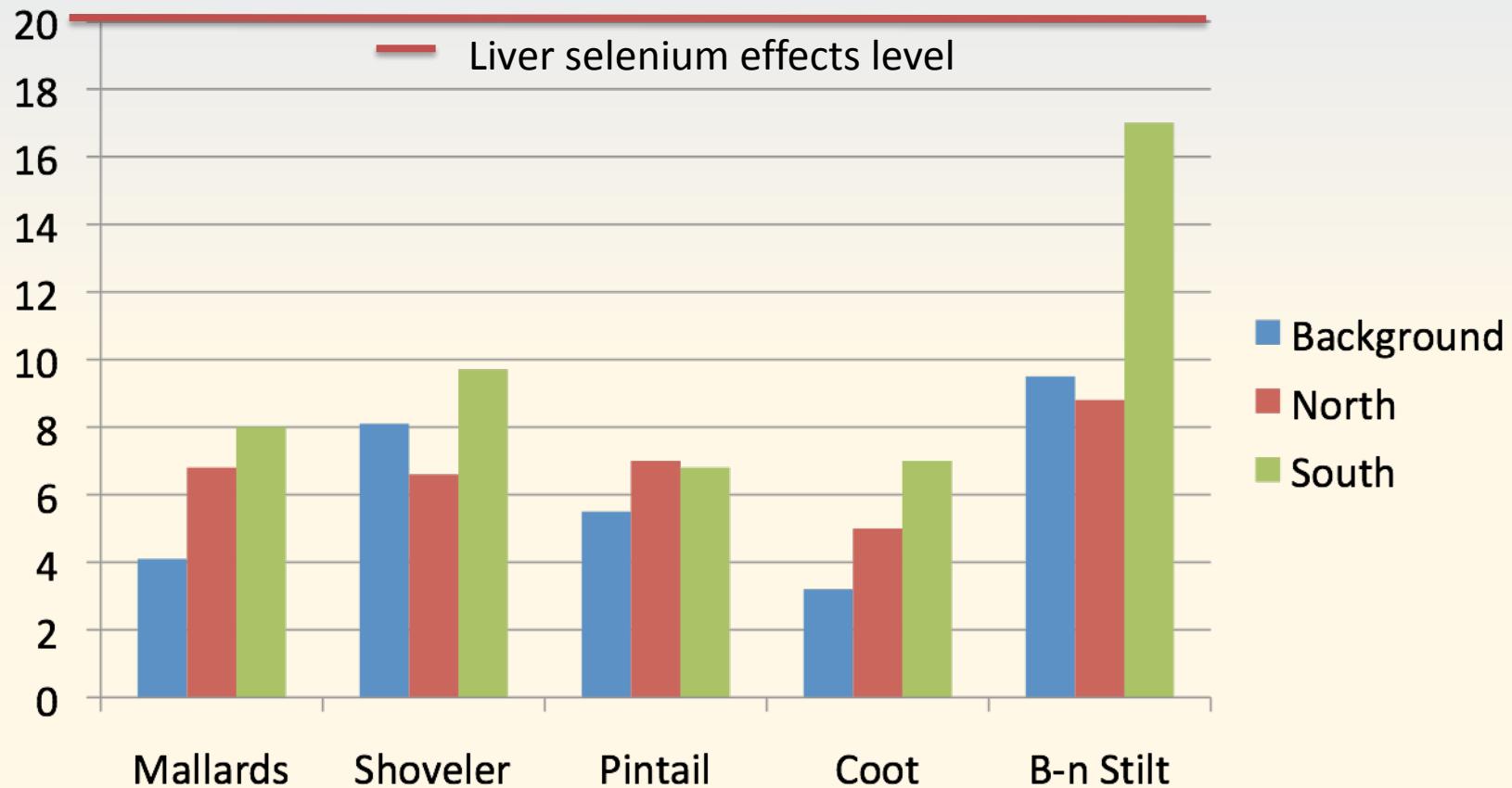
Grassland Revisited

Liver Selenium Historical



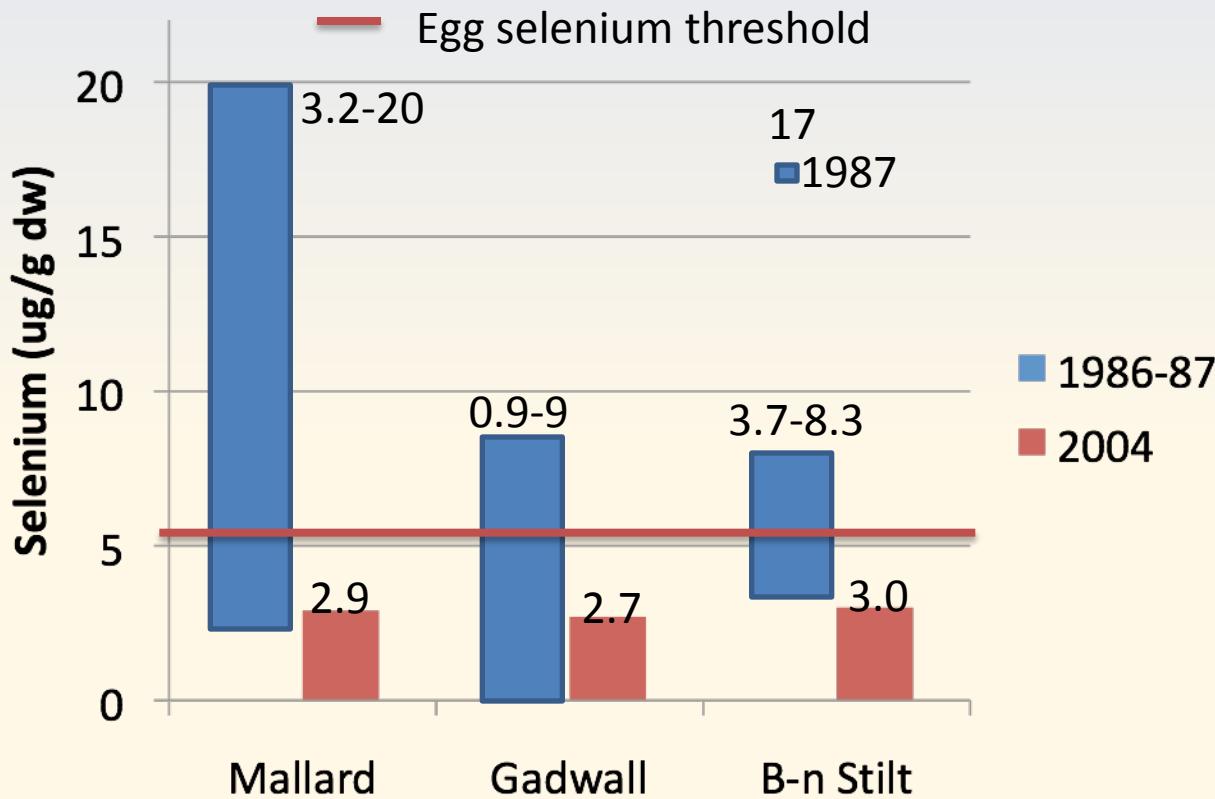
Grassland Revisited

Liver Selenium 2005



Grassland Revisited

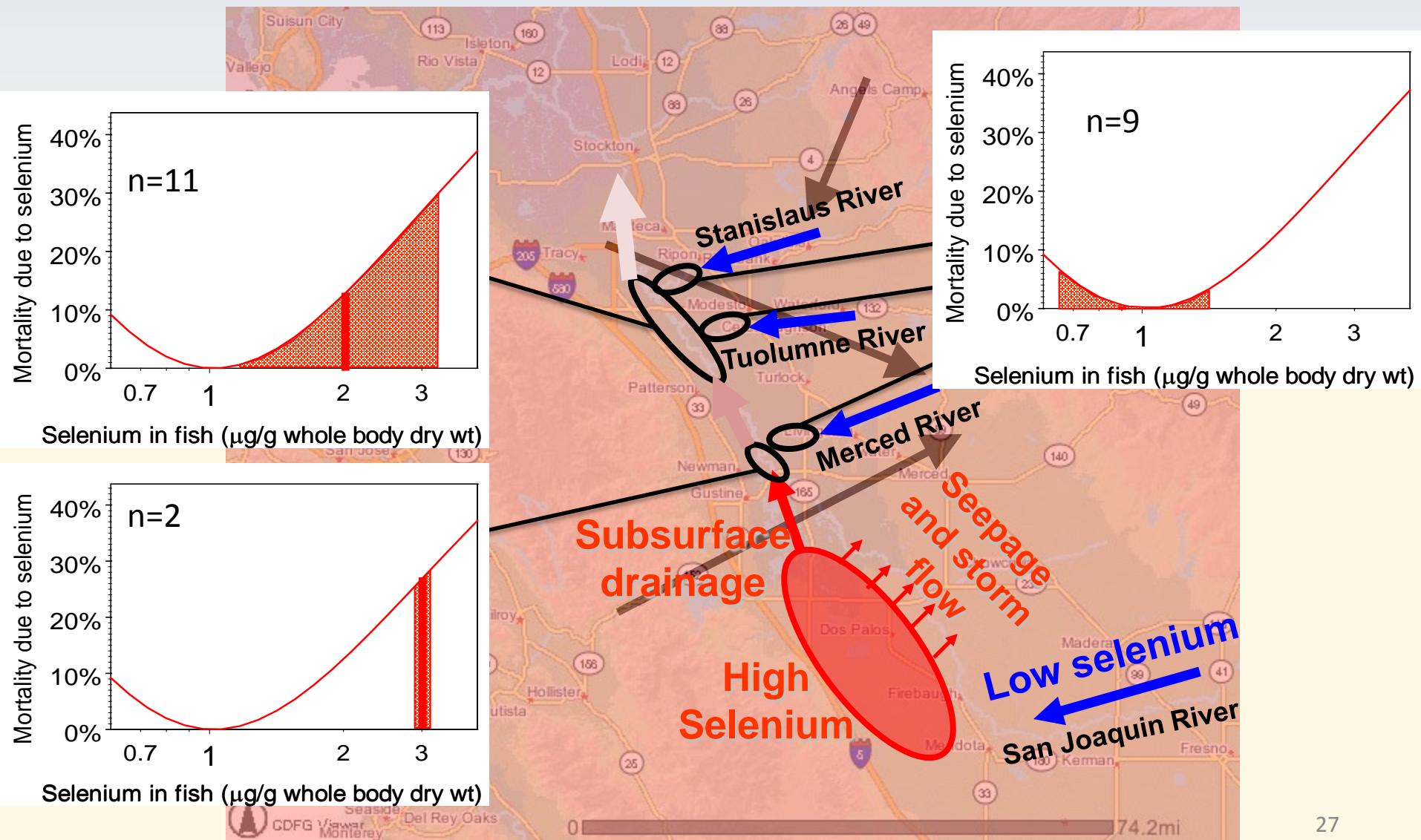
South Grassland Eggs



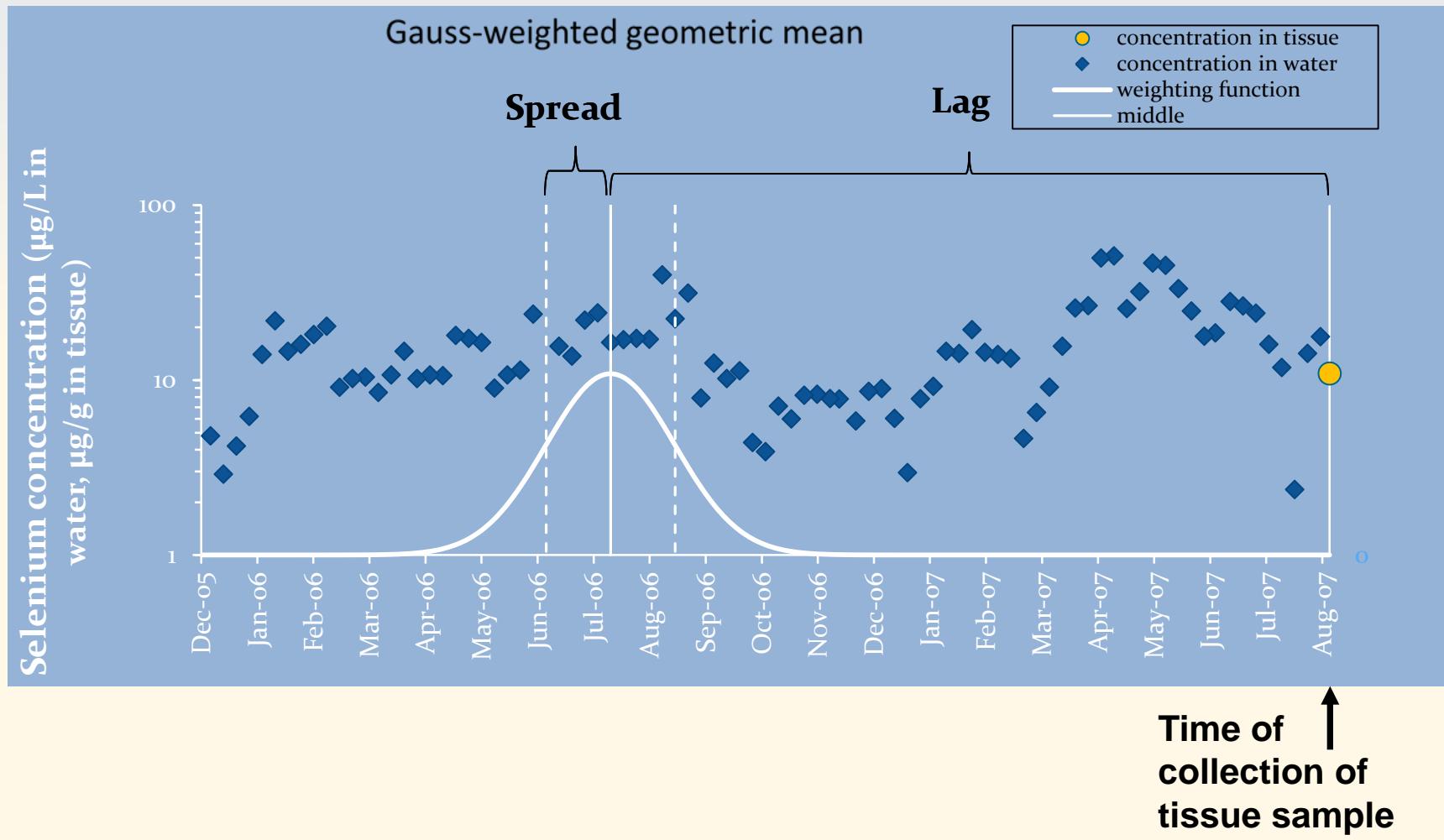
Grassland Revisited Summary

- Selenium concentrations in adult birds are static at slightly elevated levels.
- Selenium concentrations in bird eggs have declined to slightly elevated levels but now below level of concern.
- Due to recycling of residual selenium in the ecosystem.
- Continued discharge of selenium from controlled and uncontrolled sources in addition to large storm events.

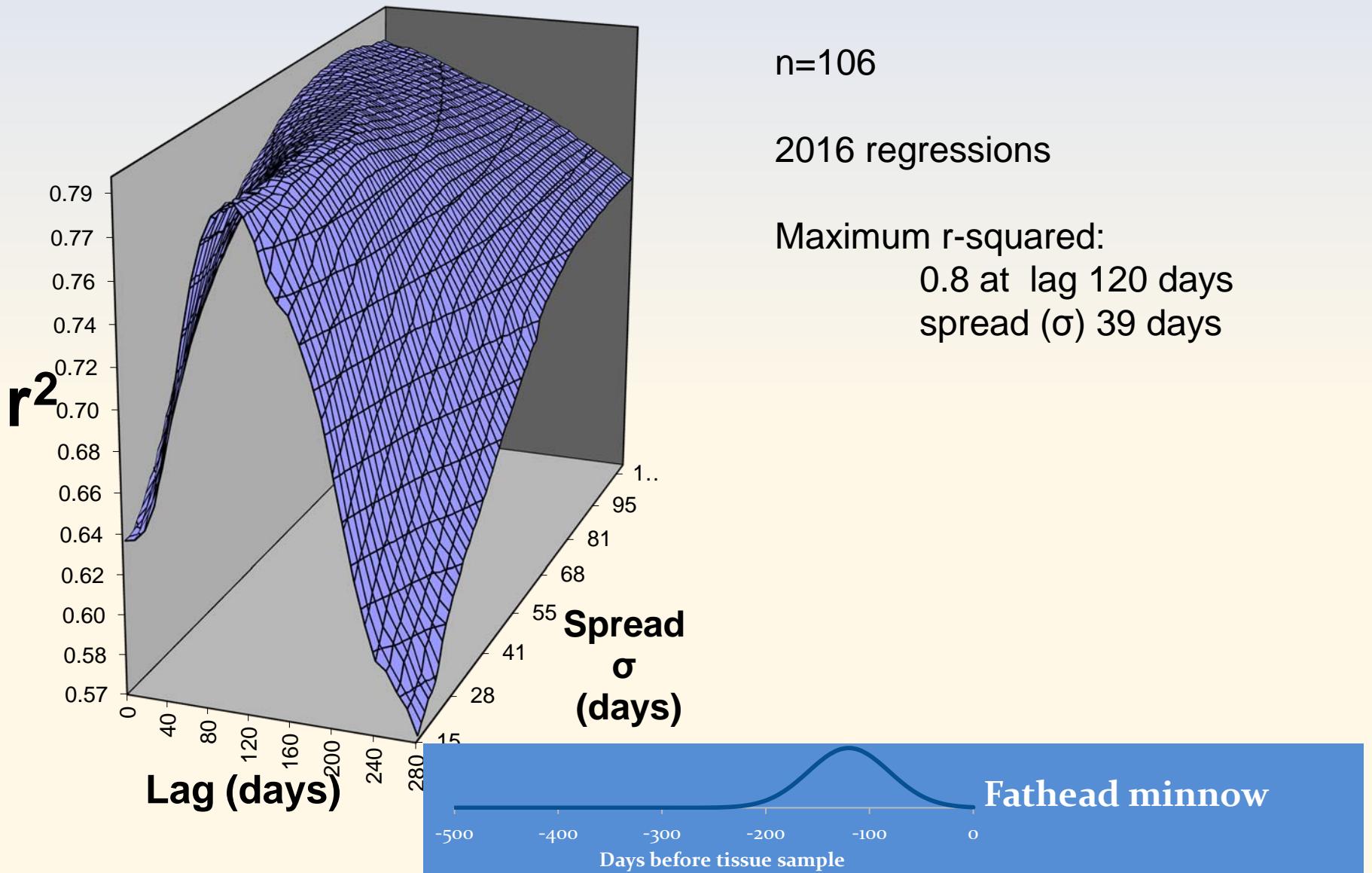
Selenium risk to juvenile salmon



Se Lag Time Analysis

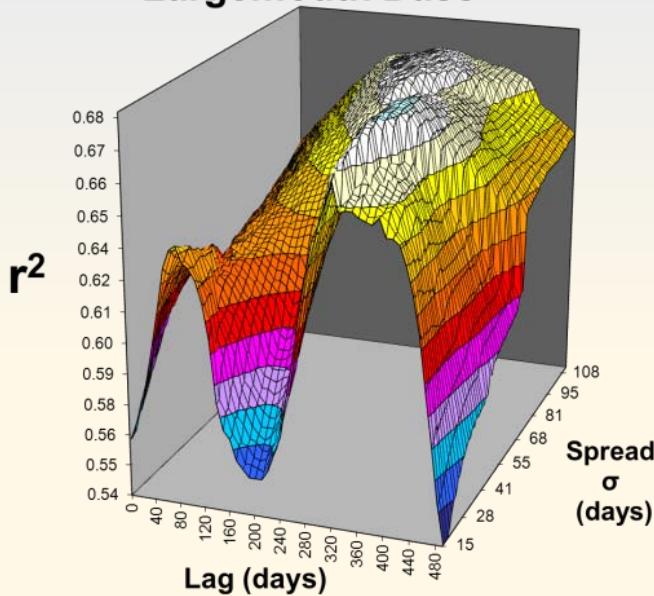


Fathead Minnow

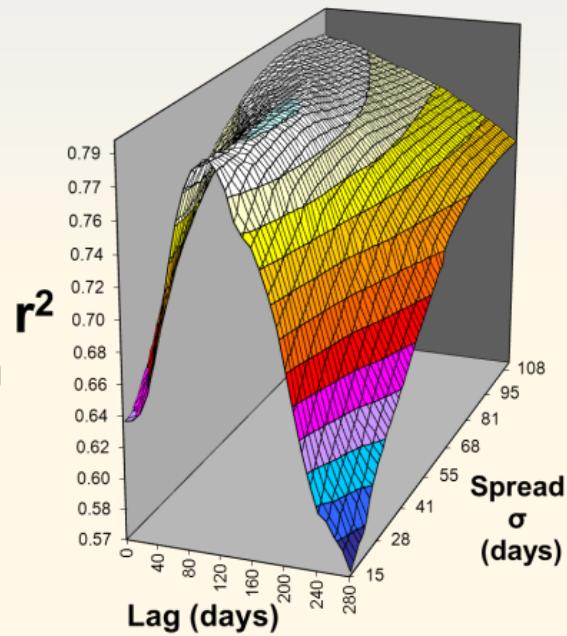


Se Lag Time Analysis

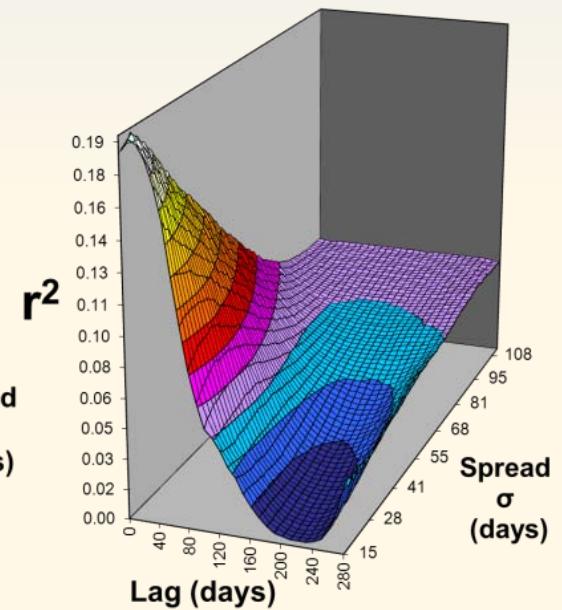
Largemouth Bass

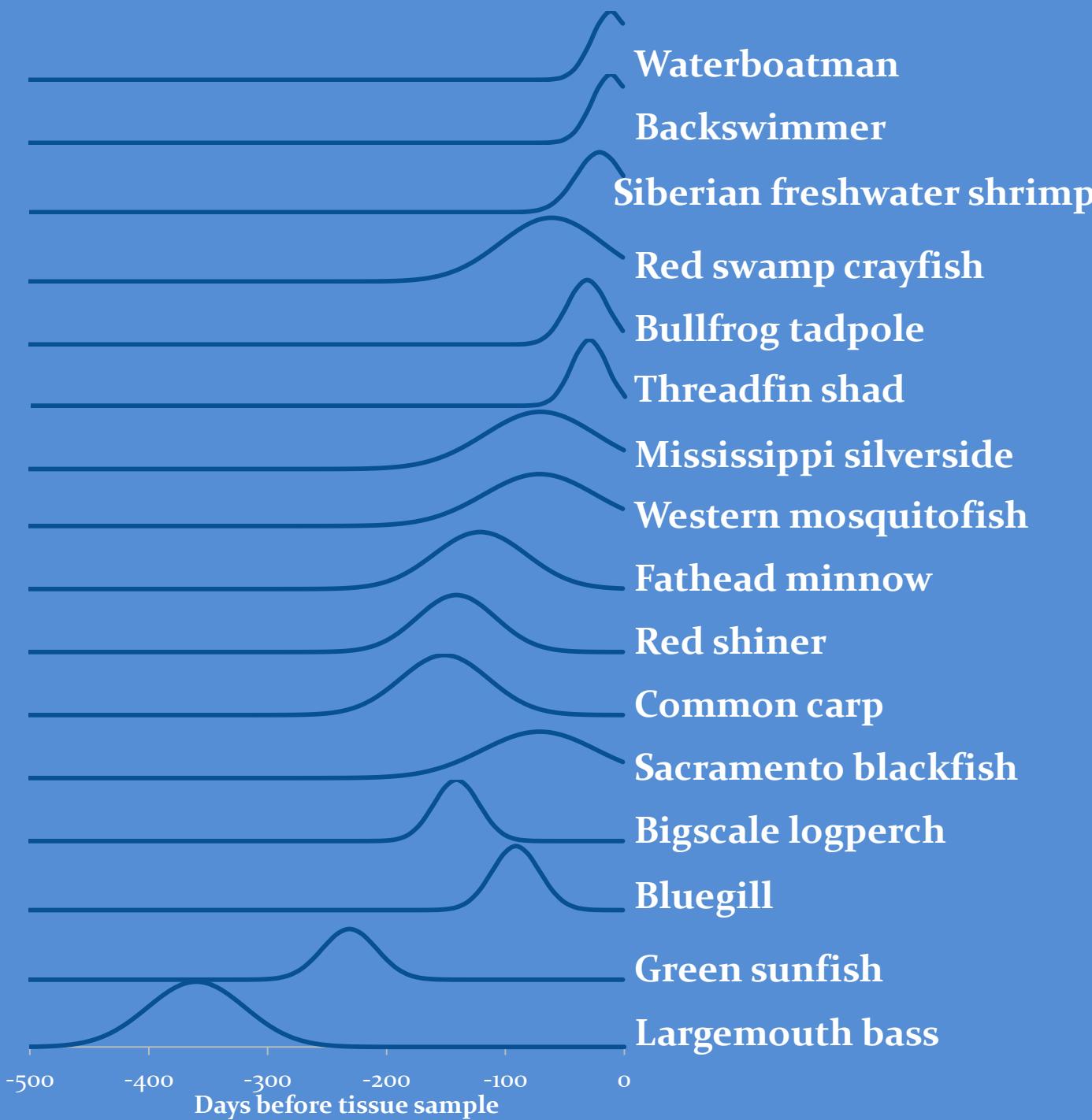


Fathead Minnow



Backswimmer





Overall Summary

- Removal of selenium from Salt Slough has led to selenium concentrations in biota below levels of concern.
- Mud Slough below the Bypass discharge continues to be impacted by selenium with concentrations in biota at levels of concern and above toxicity levels.
- Bird egg concentrations in the Salt and Mud Slough areas have declined to below concern levels.

Overall Summary

- Selenium concentrations in adult birds and eggs across Grassland area are static at slightly elevated levels but below levels of concern.
- Recycling of residual selenium in the ecosystem appears to be continuing.
- Continued discharge of selenium from controlled and uncontrolled sources in addition to large storm events.

Grassland Bypass Project

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